Appendix B

Watershed Tools

Introduction

This appendix describes the tools that should be provided in DDAP to define Watershed boundaries, manage Watershed information, subdivide Watersheds into zones, and determine various properties associated with Watersheds. The breakdown of a Basin into Watersheds and zones within Watersheds could vary from one Basin analysis to another, thus a PETA must be selected prior to using the Watershed tools.

PETA Selection

When the Watershed category is chosen, the user should first be given a list of PETAs that exist for the Basin. The user will then choose the appropriate PETA. For the Watershed tools it doesn't appear that the period of record (HPOR or an extension) should affect the analyses, thus there is no need to make a period of record choice.

Basic Display

Once a PETA has been selected, the basic display for the Watershed tools window should contain the following in addition to overlay, zoom, query, and units features:

• Basin boundaries - i.e. the overall boundaries of the Basin currently selected as specified in the Basin definition (not Watershed boundaries),

• Watershed boundaries for all Watersheds currently defined for the Basin and PETA selected (headwater and local area boundaries should probably be in different colors), and

• The following overlays should be turned 'on' - Rivers and streams and sites with historical streamflow records.

Menus

Control and Tools menus should be included. The Control menu only needs a Quit option. The tools menu should contain 3 basic choices with options as follows:

1. Watershed Boundaries
   • Define
   • Modify
   • Delete

2. Watershed Subdivision
   - Elevation Zones
   - Travel Time Zones

3. Watershed Properties

Each of the 3 basic Watershed tools are described in this appendix starting on separate pages.

Data Base Consideration:

Besides storing the information indicated on the following pages of this appendix when a Watershed boundary is defined, modified, subdivided, or properties computed, linkages need to be maintained between each Watershed and the precipitation, temperature, and evaporation time series that are generated for the Watershed and its subdivisions. These time series can include the HPOR and each extension period. Information that shows which time series exist for a given Watershed for each of the record periods needs to be maintained.

Watershed Boundaries

Overall Function: Used to define and manage Watershed boundaries. There are 3 options under this tool. They are Define a Watershed boundary, Modify a boundary, and Delete a boundary. Each will be described separately.

Define

Function: Define a Watershed boundary using GIS based techniques.

User Specification:
- Watershed identifier - default based on station ID at outlet point (user can change)
- Outlet Point,
    ◦ Streamflow data site (could be historical or operational), or
    ◦ Enter latitude, longitude, and possibly elevation.
- Upstream Inflow Points (only if a local area),
    ◦ Upstream streamflow data site, or
    ◦ Enter latitude, longitude, and possibly elevation.
- Drainage area,
    ◦ For Watersheds defined by historical streamgage sites, the drainage area should be computed from the meta files for each location, and
    ◦ For Watersheds defined by latitude, longitude points, the drainage area can optionally be input by the user.

Method: Boundary automatically determined using the currently most appropriate GIS technique utilizing elevation and stream network data sets. Warning should be generated when the drainage area computed from the boundary points disagrees by more than a prescribed tolerance from the area input.

Display Generated: Derived Watershed boundary (adjusted to fill screen) with topography and stream network overlays 'on'.

Output: Watershed boundary (record designed so that it can be later modified and expanded to store zone information and properties). Both input and computed drainage area should be stored with the boundary definition. Stored when user Okays the results.

Modify

Function: To manually modify a Watershed boundary for cases where automatic determination of the boundary produces erroneous results.

User Specification: Watershed boundary identifier.

Checks: Boundary cannot be modified if zones have already been defined or properties have been computed

Display Produced: Enlarged view of the watershed boundary (adjusted to fill screen) with topography and stream network overlays 'on'.

Method: User drags existing boundary points to new locations (can use zoom feature). Drainage area computed from the boundary points is modified as the boundary points are altered.

Output: Updated Watershed boundary stored when user Okays results. Also new computed drainage area.

Delete

Function: To delete a Watershed boundary or to remove property or zone information from a Watershed definition.

User Specification:
- •Watershed boundary identifier, and
- • Specification of what is to be deleted:
    - ◦ Entire Watershed definition,
    - ◦ Definition of subdivisions and their properties, or
    - ◦ Watershed and zonal property information.

Checks: If precipitation, temperature, or evaporation time series exist for the Watershed or its subdivisions, the user must be warned that deleting the watershed or its subdivisions will cause the time series to also be deleted.

Output; (if user okays all warnings)
- • Watershed definition is either modified to remove subdivision and property information or the definition is removed from the data base depending on the user input,
- • If subdivisions or the entire Watershed definition is deleted, all precipitation, temperature, and evaporation time series associated with the subdivisions or the Watershed are also deleted.

Watershed Subdivision

<u>Overall Function:</u> To divide a Watershed into zones or subareas based on some physical property. There should likely be 2 options initially under this tool. These are Elevation Zones and Travel Time Zones.

<u>General User Specification:</u> Watershed boundary identifier (applies to both options).
<u>General Considerations:</u> If the Watershed is already subdivided, the subdivisions must first be deleted and then new zones established.

Elevation Zones

<u>Function:</u> To subdivide a Watershed into zones based on elevation. A special consideration is that some Watersheds with a significant range in elevation can contain glaciers. Glaciers are typically assigned to a separate zone based on the average areal coverage of the glacier over the period of record.

<u>User Specification:</u>
- Does a glacier exist - if yes, the glaciated area must first be delineated and then removed from the Watershed when designating the elevation zones,
- Use option to derive elevation breakdown based on areal snow cover records and historical streamflow data - if chosen, the Watershed must have a historical streamflow data site at the outlet, must be a headwater drainage or a local area with a local drainage area contribution streamflow time series generated (see Local Area Flow Computation tool in Appendix A) - if site has multiple streamflow time series (e.g. observed and adjusted), the user selects the appropriate series to use - satellite areal snow cover images must also be available that overlap with the streamflow period of record,
- Elevations that divide each zone (elevations must be within the range of elevations for the non glaciated portion of the Watershed), and
- Identifiers to use for each zone defined including glaciers (default based on naming convention using Watershed ID and subscript - can be overridden by user).

<u>Basic Displays:</u>
- Watershed boundary with topographic overlay 'on' - glaciated area shown after it is delineated - contour lines highlighted when zones defined.
- Area-elevation curve for the Watershed - curve redrawn for the non-glaciated portion of the watershed once the area covered by glaciers is delineated.

<u>Method:</u>
- Delineation of Glacier covered area - method will depend on whether spatial data sets available show glaciated areas. If such data sets are not available, the user could manually outline the glacier covered portion of the Watershed.
- Derivation of elevation zones using overlapping streamflow and areal snow cover data (procedure described in Section 6-1 of the Calibration Manual).

◦ User selects year from list of water years that have overlapping flow and snow data,
◦ User selects date from list of dates for the water year that have areal snow cover images,
◦ User determines average snowline elevation over the Watershed using the snow cover image with the Watershed boundary delineated - various methods could be used to estimate the average snowline elevation including averaging point values, pattern recognition, and automatic computation,
◦ Snowline elevation for each date analyzed is labeled on the hydrograph as shown in Figures 6-1-1 and 6-1-2 of the Calibration Manual, and
◦ User examines as many years and dates as needed before subjectively analyzing the results to determine the zonal elevation divisions.

Output: (after user Okays elevations specified to divide zones)
• Modify Watershed boundary definition to include elevation zone information including identifier for each zone, glacier boundary, and elevations dividing zones for the non-glaciated portion of the watershed.

Travel Time Zones

Function: To subdivide a Watershed into equal travel time zones.

User Specifications:
• Time interval on which to base travel time zones, and
• Average velocity of water moving over the land surface and through the stream network (could possibly be computed based on channel slope and other information).

Method: Using the average velocity, the stream network, and the Watershed boundary, compute the portion of the basin that would contribute flow during each time interval. The most downstream zone should be based on ½ the time interval and all other zones on the full interval.

Display Generated: Watershed boundary with rivers and streams overlay 'on' and each travel time zone delineated.

Output: Modify Watershed boundary definition to include the information needed to define each travel time zone and the fraction of the total area within each zone. Stored when the user Okays the results.

Watershed Properties

Function: To determine various physical properties of each Watershed and any subareas defined to use when performing data analysis or selecting model parameters.

User Specification: Watershed boundary identifier.

Properties: Each determined for the entire Watershed and for each subarea.
- Area-elevation curve,
- Mean elevation,
- Vegetation breakdown (if possible, percent conifer trees, deciduous trees, agricultural, grassland, and no vegetation cover - also types of vegetation for each category when available),
- Soils breakdown - specific information depends on data bases available, and
- If zones exist, the fraction of the Watershed area in each zone and the total area of each zone.

Displays Generated:
- Area-elevation curve plots with mean elevation indicated, and
- Tables summarizing the vegetation, soils breakdown, and fractional and total areas (if zones exist).

Output: When results Okayed by the user.
- Area-elevation curves,
- Mean elevations,
- Vegetation and soils information, and
- If zones exist, the fractional and total area for each zone.